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6 LONG-TERM FISCAL IMPLICATIONS OF SUBSIDIZING IN-VITRO FERTILIZATION IN SWEDEN: A LIFETIME TAX PERSPECTIVE

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Background: In Sweden approximately 3% of annual births are conceived using assisted reproductive technologies (ART). In light of increasing use of ART in Sweden we estimate the lifetime future tax revenues of an in-vitro fertilisation (IVF) conceived child to establish whether public subsidy of IVF represents sound fiscal policy.

Methods: A modified generational accounting model was developed to calculate the net present value (NPV) of average investment costs required to achieve an IVF conceived child. The model simulates direct lifetime financial interactions between the child and the Swedish government. Within the model we assume average direct financial transfers are made to the individual (eg, child allowance, education, healthcare, pension, etc). In return, the individual transfers resources to the government through taxation based on anticipated average earnings. The difference between direct transfers and gross taxes paid equals the net-tax contribution. Individual tax contributions were held constant in the model.

Results: Based on average life-expectancy an individual born in 2005 will pay an undiscounted 32.5 million SEK in taxes to the Swedish government and receive 20.9 million SEK in direct financial transfers over their lifetime. When these figures are discounted and IVF costs are included in the analysis we obtain a lifetime NPV of 254,000 SEK with a break-even point at age 41 (the age of achieving a positive NPV) for an individual conceived through IVF.

Conclusions: Based on results presented here we conclude that State-funded IVF in Sweden does not negatively impact the long run fiscal budget. Conversely, over their lifetimes IVF-offspring returns a net positive value to the State.

Introduction

Over the past decade there has been increased use of assisted reproductive technologies internationally resulting in an increasing proportion of annual births attributed to this technology.[1] Sweden is no exception where approximately three percent of annual births are attributed to ART.[2,3] Increasing demand for ART services is attributed to a variety of factors including higher prevalence of infertility brought about by delays in time to first pregnancy, increasing obesity, sexually transmitted disease and a growing awareness and acceptance of the available technology to treat infertility.[4,5,6,7]

Despite increasing medical need for infertility treatments, the demand for healthcare outstrips available resources and many health authorities are forced to make rationing decisions about which services to provide. Unfortunately many health authorities view medical infertility as a low health priority and consequently have provided limited resources for treating infertility.[8,9] As a result, since many couples are unable to afford treatment, they are forced to forego IVF treatment.[9,10,11]

In Sweden the health care system is publicly funded and the ethical platform for prioritising health care rests on three basic principles; (1) the principle that all humans have the same value; (2) the principle of need and solidarity which means that resources should be used where they are needed the most; and (3) the principle of cost-effectiveness.[12] With these guiding principles, four priority groups are established, ranking infertility in Priority group III (out of IV).[13] As infertility is included on the priority list, IVF treatments at public clinics are fully reimbursed by the National health care system.[14] However, the National health care system has established limits on the number of IVF-cycles covered by the system and which indications allow couples treatment. This has caused waiting-lists for treatment which exacerbates the situation because of the impact of age on fecundity. This forces many couples to pay for treatment outside of the publicly subsidised system. A recent study indicated that 68% of ART expenditure in Sweden was publicly financed with the remainder financed privately.[15]

In recent years, in view of the increasing numbers of children born using ART, there has been growing interest in infertility treatments amongst demographers seeking to understand how ART could potentially influence population ageing trends.[16,17,18] Traditionally demographers have focused on understanding why birth rates are falling and which social and economic factors influence fecundity, however more recently attention has focused on those people that are 'willing but unable' to have children.[17,19,20] The numbers of infertile couples are not small; some estimates suggest up to 1 in 7 couples can face reduced fecundity at some point in their lives.[5,21] Furthermore, when the increasing numbers of children born from ART every year are positioned within the ageing populations currently affecting many countries it is useful to understand how policy which influences access to ART impact on total fertility rates.[16, 18]

In light of increasing reliance on ART by couples for conception, we sought to understand whether public subsidy of ART represents sound fiscal policy for governments - in this example the Swedish government. Moving beyond the benefits to the individual couple undergoing IVF treatment, we sought to understand the long-term fiscal benefits to the State. Thus, the purpose of this study was to assess the long run net fiscal implications from the perspective of the State. The underlying assumption being that State subsidized IVF is an investment which can influence future government revenue when a longer time horizon is applied. In order to test the concept we have developed a model which uses a single individual conceived through ART, assumed to be average in every respect to a naturally conceived child, and assessed whether investing in IVF is financially sound. It is hoped that this analysis can be used to inform health policy and legislative policies which influence financing decisions and access to reproductive treatments.

Methods

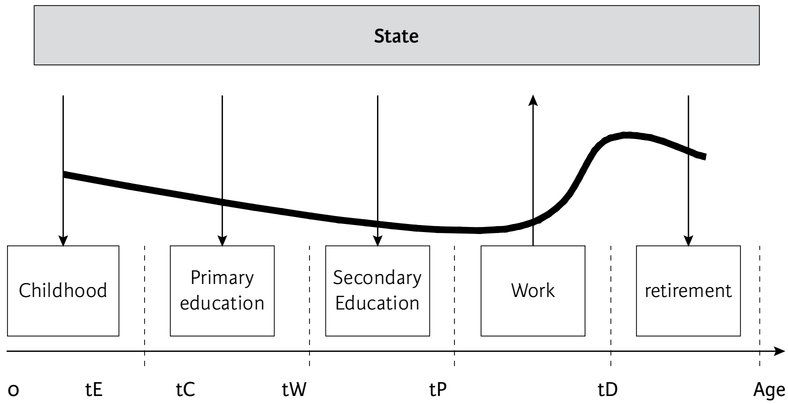
Model design

The model quantifies the long-term net tax implications of IVF funding attributed to a single individual. The average costs required to conceive an IVF child are treated as an investment with long-term fiscal implications. The model describes the lifetime financial interaction between the State and a hypothetical IVF conceived child born in 2005 with a life expectancy of 80 years. In this contract the person pays money into the State budget through tax (positive cash flow for the State), while the State makes direct financial transfers to the individual in the form of social services such as education and healthcare (negative cash flow for the State). The marginal cost for congestible items such as roads, fire and police protection, airports, sewers, etc are not included in the analysis which would negligibly influence the results.

Modelled Life stages

Within the model we assume a number of life stages as shown in Figure 1. During the early stages of life the State contributes towards an individual's education and healthcare costs. The situation changes when the individual enters their working stage; now the State still contributes to healthcare costs, however an average individual has a positive balance because they contribute more to the State in the form of taxes than they receive in benefits. Finally, after retirement, the State helps support citizens until the end of their life in the form of healthcare and pensions.

Figure 1 Lifetime financial interaction between individual and State



Note: The base case values of the above constants are defined in the model as follows: t_E=7, t_C=16, t_W=20 and t_P=60.

Each stage has very specific characteristics that differ between the stages. Mathematically this implies a different set of equations for each stage:

$$(1) \quad NPV\left(t_0\right) = \int_{t0}^{tE} D_Y\,dt + \int_{tE}^{tC} DYdt + \int_{tC}^{tW} DYdt + \int_{tW}^{tP} DYdt + \int_{tP}^{tD} DYdt - IVF - Ch$$

At any time, the balance or net return, NL, to the state is given by:

$$(2) \quad N_L(t) = T(t) - C(t) - E(t) - H(t) - G(t) - P_S(t)$$

Where T(t) is the tax revenue of the State; C(t) E(t), and H(t) are costs to the State for child allowances, education, and healthcare, respectively. Geriatric care and state pension are represented by G(t) and PS, respectively. The methodology described here is based on generational accounting modelling techniques developed by Kotlikoff.[23] For simplicity, we have represented tax collection and financial transfers for the three levels of government (eg, federal, county and municipalities) within the model as an aggregated unit.

At birth, the new born costs a sum, Ch. Since the baby is conceived using IVF, a further cost, IVF, is added. In this context, the State can be seen to make an investment, which in time will lead to a return. The size of the return on investment in present value is estimated using NPV calculations to evaluate the return on investment in present terms.

Table 1 Variables included in model to derive net present value of IVF investment costs to derive a live birth in Sweden

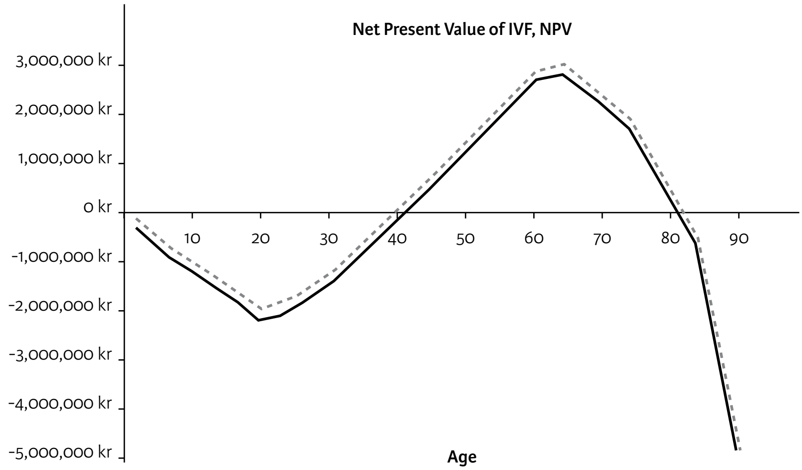
Parameter	Estimates (2005)	Notes and references:
Applied discount rate	2.5%	Based on recommendations by the Swedish National Financial Management Authority. [25]
Economic Growth	2.8%	Based on historical growth rates since 1950. [26]
Growth in Healthcare expenditure	4%	OECD health database. [27, 28]
Direct financial transfers from government to individual		
cost per successful IVF live birth	205,000 SEK	Derived from Granberg *et al* and adjusted for growth in healthcare expenditure from 2001-2005.[15]
cost per delivery	23,939 SEK	Swedish Association of Local authorities and Regions. [29]
Child allowance	12,600SEK/ child/year up to age 19	The allowance increases with economic growth.[30]
Educational expenditure	75,850SEK	Education costs are assumed to increase with economic growth.[31]
Healthcare	13,782SEK average annual cost per person (2005)	Age-adjusted healthcare expenditure is based on county of Skåne.[32]
State pension	116,800 SEK average annual cost per person	Costs to government of basic state pension are considered.[33]
Geriatric care	72,000SEK average annual cost per person	Geriatric costs are assumed to increase with economic growth.[34]
Income tax	30%	Swedish Tax Agency 2008. Taxes in Sweden 2007. A summary of the Tax Statistical Yearbook of Sweden. Swedish Tax Agency, Stockholm.
Value Added Tax (VAT)	25%	same as above

$$(3) \qquad NPV\left(t_0\right) = \int_{2005}^{2085} \frac{N_L(t)}{\left(1+r\right)^t}\,dt - IVF - Ch$$

Where r is the discount rate and t=0 is assumed to be year 2005. The integral represents the discounted, time-aggregated balance interaction between the state and the individual. The costs *IVF* and *Ch* represent the initial 'investment' from the State.

The critical model inputs and a brief explanation are provided in Table 1. The other equations used in the model are explained in Figure 1 and in the technical appendix.

Figure 2 Lifetime discounted financial position between naturally conceived and IVF conceived child and the State



Results

The lifetime discounted financial interaction between an IVF- conceived and naturally conceived child and the State are shown in Figure 2. Additional costs to the state for an IVF conceived child are demonstrated by having a more negative financial position with the state at birth. The breakeven point for both IVF conceived and naturally conceived children are also shown in which this is achieved at age 41 and 40, respectively. The discounted financial trace also demonstrates that the cost increases once again upon retirement due to costs of state pensions, healthcare and elderly care.

Based on average life-expectancy an individual born in 2005 will pay an undiscounted 32.5 million SEK in taxes and receive 20.9 million SEK in direct government transfer over their lifetime. The difference between these figures represents the undiscounted lifetime surplus tax payments. When average investment costs required to conceive a child are evaluated in the NPV model, the present value of investing in IVF to the State is approximately 254,000 SEK (based on average life expectancy). At old age, a point is reached at which the aggregated costs of an average person to the government again outweigh the lifetime revenues. From this point forward the financial position remains negative until the person has died.

For comparison, NPV calculations for an individual conceived naturally were also calculated in which the only differentiating variable between IVF

Table 2 Lifetime net present value and breakeven age from perspective of Swedish government for naturally conceived and IVF conceived children

Scenario	Lifetime NPV (SEK)	Breakeven age
Naturally conceived	459,000	40
Cost of IVF conceived child (base case derived from Granberg)	254,000	41
Cost of IVF conceived child increased by 46% to 300,000 SEK	159,000	42
Cost of IVF conceived child increased by 95% to 400,000 SEK	59,000	43

conceived and naturally conceived child is the costs of IVF to the government. Hence, the corresponding breakeven age for a naturally conceived individual is 40 years and he/she has returned 459,000 SEK in net present value to the State at the age of 80.

Because IVF success is age-dependent and older couples frequently require more treatment cycles and consequently increased costs to obtain a live birth, we have varied treatment costs to reflect the need for additional cycles to achieve a live birth and whether this would influence our conclusions.[5] When the average cost of achieving a live birth are increased by 46% and 95% the lifetime value of the investment changes to 159,000 SEK and 59,000 SEK, respectively.

Sensitivity analysis

To test the robustness of the model we varied a series of parameters likely to impact conclusions found in the base case scenario. The model was found to be sensitive to the age at which retirement begins as demonstrated in Table 3. An increase in the average growth of healthcare influenced the results, particularly as healthcare costs increase dramatically in older age (Table 3). Furthermore, the model was found to be insensitive to changes in the child allowance and only slightly sensitive to the costs of education and geriatric care (variables not shown).

Critical financial variables including income tax rates, economic growth and discount rate were also varied in the sensitivity analysis. Because government revenue is dictated by tax rates the model was extremely sensitive to the average lifetime level of taxation applied. An increase in economic growth from the baseline 2.8 percent to 3.8 percent would reduce the breakeven age by three years and increase the net return to the State to 3,140,000 SEK. Furthermore, an increased discount rate increases the breakeven age and decrease the net return to the State.

Table 3 Change from base case in model parameters likely to influence financial position between individual and State†

Parameter	Lifetime NPV (SEK)	Breakeven age
Changes in tax Rate (income tax + VAT)		
Decreased to 50%	-515,000	43
Increased to 60%	1 023,000	40
Economic Growth (% increase in GDP)		
1.8 %	-1 534,000	47
3.8 %	3 072,000	38
Discount rate (%)		
1.5 %	-16,000	38
3.5 %	45,000	46
Changes in average retirement age		
Aged 55	-403,000	41
Aged 65	827,000	41
Average annual increase in healthcare expenditure		
3.0 %	1,827,000	41
5.0 %	-2,851,000	42

† Base case assumes 55% average taxation rate, discount rate of 2.5%, economic growth 2.8%, average retirement age 60, healthcare expenditure increases 4% annually.

Discussion

The analysis presented here has evaluated costs attributed to treating IVF as an investment in health with future revenue implications for the State. The foundation on which this approach rests comes from fact that as individuals transition from childhood to adulthood they become economically active, and that through participation in economic activities a proportion of this economic benefit passes to the state through taxation. This methodology is based on the principle that ART enables couples to have children; children that would not have existed were reproductive technologies not available. If one accepts this premise then it is conceivable that barriers which prevent couples from accessing reproductive services could have a long-term cost seldom considered. It is only through calculating the lifetime tax calculations we can begin to understand what that cost might be. This work was undertaken with the explicit aim of raising awareness of these potential costs, and benefits, and providing policy-makers with a more comprehensive understanding of the benefits attributed to ART.

The methodological approach describe here is unique when compared to previous economic studies of ART which tend to focus on costs over shorter time periods and do not consider the economic benefits when children reach adulthood and become employed.[15,36] This illustrates some of the technical issues that need to be considered in economic evaluations which includes clearly defining the economic question to be explored, from whose perspective will costs be considered, and the timeframe over which the effect is to be measured.[37] For example, if one seeks to understand the costs of IVF treatment to the health service then it is appropriate to look at costs over a short period of time.[15] However, if one seeks to evaluate the long-term societal costs and benefits of IVF programmes then it is appropriate to consider a broader range of costs and a longer time horizon over which costs and benefits can accrue. On this point we believe that applying the generational accounting methodology which was developed explicitly to look at future government expenditure and revenue over a long time period is an appropriate methodology for evaluating ART benefits.[23]

One of the major criticisms of this work is likely to be the simplifying assumption in the calculations that an IVF child is average in every respect to naturally conceived children. In fact, there is considerable evidence highlighting the risk of multiple pregnancies attributed to IVF which increases the likelihood of preterm delivery and consequently lower birth weights and increased hospitalisation costs.[36,38] A rough estimate by Granberg indicates that neonatal care costs of IVF infants are increased by approximately 27,000 SEK compared to that of a "normal" new born.[15] That would correspond to a 13% increase in the cost associated with IVF and thus a NPV that would decrease to 227,000 SEK. There is also evidence indicating that IVF children have an increased morbidity even after the neonatal period. For example, Koivurora et al. concluded that IVF children were significantly more frequently admitted to hospital and spent significantly more days in the hospital than control children.[39] Similar criticisms could be made based on the age of women undergoing IVF which are on average higher than mothers conceiving naturally which presents an increased risk of complicated pregnancies.[40] It is likely that taking into consideration long-term cost consequences of being born premature would adversely influence the simulations presented here. However, we believe this research complements previous research which highlights the economic benefits of limiting the number of embryos transferred in IVF to minimise multiple pregnancy rates.[41] In the Swedish context, there has been considerable effort to lower the multiple pregnancy rate from as much as 32% in 1991 to 6.5% in 2004.[3] Today, single embryo transfer is standard and is in accordance to the guidelines of the Swedish Board of Health and Welfare which has reduced the multiple pregnancy rate, with likely cost savings attributed to reduced preterm delivery costs.

Another methodological limitation concerns the role of the State. Theoretically, from an economic perspective the State has two roles. One is to transfer funds between individuals and between different time periods during the life of an individual which has been taken into account in the model. The second role is to provide pure public goods and services which cannot, or will not, be produced by the private sector. This is excluded in the model. Implementing the costs of the provision of public goods in the model will, ceteris paribus, alter the fiscal impact of an individual born in 2005.

The model assumes that there are no asymmetries between IVF births and normal births. This will affect the estimates of costs and benefits of the two target groups to the extent that a newborn child's socio-economic background determines its future in education, labour market, healthcare and life expectancy. For various reasons, it is likely that there are statistical differences between the characteristics (in terms of education, income, social status, etc.) of the two populations of couples who currently undergo IVF treatment and those who do not. These and other characteristics have not been included in the analysis.

The model illustrates that an IVF conceived child born in 2005 will return a lifetime positive NPV to the government of 254,000 SEK. While the present value (ie. return on investment) of funding (ie. investing) IVF may appear minimal, it is important to consider that the purpose of government is not profit maximising. This perspective is reflected by applying lower discount rates to public investments where benefits are likely to accrue over generations.[24,42] Consequently, for the state, the present value of investing 205,000 SEK results in approximately a 24% return on capital which would satisfy most corporations and can be considered more than adequate for government investments.

As the present study is based on Swedish data it is important to emphasize that the results presented here may not be valid for other countries as the tax- and welfare systems may differ significantly. It is likely that the costly, well developed, Swedish welfare system has a negative effect on the NPV of an IVF-conceived child. A similar study in the U.K., a country with a less expensive welfare system, supports this notion as that study indicated a larger net return to the government compared to the results presented here.[43]

Conclusions

In this paper we have applied generational accounting techniques to evaluate the long-term financial impact of an IVF child conceived from State subsidized IVF treatments in Sweden. Our results indicate that when a longer time horizon is utilised and a broader range of costs and benefits (ie. tax-contributions) are used to evaluate IVF treatment costs, the economic benefits to the Swedish government exceed the cost required to conceive a single child from IVF. This would suggest that barriers which prevent people from accessing available assisted reproductive techniques would represent a financial loss to the State that could be generated through lifetime tax contributions in the future. It is envisaged that the results presented here can assist policy-makers charged with responsibility for developing and administering IVF policy by enabling them to see the economic benefits derived from children conceived using IVF.

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Technical appendix

Equations used in the model:

Tax Rate

(4) $$T(t) = \beta(I + P)$$

Where T(t) is the total Tax per person, I is Income of which a fraction, β, is paid as tax. P is total Pension, of which a fraction, β, is paid as tax.
Only income tax and Value Added Tax (VAT) are included in the model (as β).

Income

The average income, *I,* is assumed to increase with the rate of economic growth, α, over the years.

The governing equation and solution can be expressed as:

(5) $$\frac{dI}{dt} = \alpha I \Rightarrow I = I_0 e^{\alpha t} \delta_I$$

Where I_0 is the average income for each specific age. The term δ_I is a multiplier that takes the value 1 during the period tW to tP, and 0 otherwise. This means that the income term is valid only during the working stage.

Child allowance

In the model, the allowance is assumed to increase with economic growth, α, and can therefore be expressed as:

(6) $$\frac{dC}{dt} = \alpha C \Rightarrow C = C_0 e^{\alpha t} \delta_C$$

Where δ_C takes the value 1 for *age<19* and 0 otherwise.

Education

The average cost of education is assumed to increase with economic growth (α). The equation is expressed as:

(7) $$\frac{dE}{dt} = \alpha E \Rightarrow E = E_0 e^{\alpha t} \delta_E$$

Where E_0 is the average cost of education in 2005. In this case δ_E takes the value 1 for $age<t_W$, and 0 otherwise. Hence, the costs of education apply only during the stages from birth to working age.

Healthcare costs

The costs of healthcare can be described by:

$$(8)\quad \frac{dH}{dt} = \gamma H \Rightarrow H = H_0 e^{\gamma t}$$

In the model, γ reflects the rate at which healthcare spending increases. According to the OECD (2006), healthcare expenditure in Sweden increased, in real terms, by 4.2 percent annually between 1999 and 2004. Thus, the cost of healthcare is growing faster than the economy as a whole. This trend is likely to continue in the future and consequently γ is set at four percent.[27]

Geriatric Care

The cost of geriatric care is included in the model and is governed by the following equation:

$$(9)\quad \frac{dG}{dt} = \alpha G \Rightarrow G = G_0 e^{\alpha t} \delta_G$$

In the equation, G_o is the average cost of geriatric care which is assumed to increase with economic growth, α. In the equation, the term δ_G takes the value 1 for age>60 and 0 otherwise. Thus, the equation is only valid after retirement.

Pensions

In the model, three different types of pensions are considered. First, the basic state pension which should be considered as a cost for the government. Secondly, the occupational pension which an individual receives from his/her former employer and lastly, private pension savings. Neither occupational nor private pensions are considered as costs for the government. During retirement, the government receives tax revenue from all three types of pensions as they are all subject to taxation.

Further on, it is assumed that pension benefits increase with the rate of economic growth, α.

$$(10)\quad P = P_S + P_P + Po$$

$$\frac{dP_S}{dt} = \alpha P_S \Rightarrow P_S = P_{S0} e^{\alpha t} \delta_P$$

$$\frac{dP_P}{dt} = \alpha P_P \Rightarrow P_P = P_{P0} e^{\alpha t} \delta_P$$

$$\frac{dP_o}{dt} = \alpha P_o \Rightarrow P_o = P_{o0} e^{\alpha t} \delta_P$$

Where P_S is state pension, P_p is private pension and P_o is occupational pension. The term δ_P takes the value 1 for *age*>t_p, and 0 otherwise.